Cluster Title: Understand the concept of a function and use function notation.

Standard F.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

Concepts and Skills to Master

- Understand the definition of a function.
- Identify functions, including functions represented in equations, tables, graphs, or context.
- Distinguish between domain and range.
- Write a relation in function notation.

Supports for Teachers

Supports for reachers					
Critical Background Knowledge					
• Tables					
 Graphing 					
Academic Vocabulary					
Domain, range, function, input, output, corresponding, set, element					
Suggested Instructional Strategies	Resources				
 Use tables, ordered pairs, mappings, graphs, function m stories to explore the concept of a function and identify non-functions and identify the domain and range of func- 	functions and • Vertical Line Test				
Sample Formative Assessment Tasks					
Skill-based Task	Problem Task				
Do the ordered pairs (-2,5), (9,8), (4, 2), (8,9), and (2,5) represent a function? Why or why not?	Write a story that would generate a relation that is a function. Write a story that would generate a relation that is not a function.				

Cluster Title: Understand the concept of a function and use function notation.

Standard F.IF.2: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

Concepts and Skills to Master

- Write equations using function notation.
- Use function notation to evaluate functions for given inputs in the domain, including combinations and compositions of functions.
- Use function notation to express relationships between contextual variables.

Supports for Teachers

Critical Background Knowledge

- Evaluate expressions
- Familiarity with function notation

Academic Vocabulary

Function notation, evaluate, input, domain, output, range

Suggested Instructional Strategies

- Explore a variety of types of situations modeled by functions.
- Have students create contextual examples that can be modeled by linear or exponential functions.

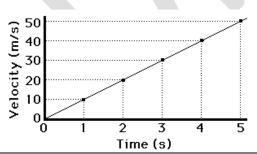
Resources

Making it Happen (NCTM)

Sample Formative Assessment Tasks

Skill-based Task

- Given $f(x) = 3^x$, find f(4).
- What does *f*(5) = 7 mean?
- Write an expression for the relationship depicted in the graph using function notation.



Problem Task

Find a function from science, economics, or sports, write it in function notation and explain its meaning at several points in the domain.

Cluster Title: Understand the concept of a function and use function notation.

Standard F.IF.3: Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for $n \ge 1$.

Concepts and Skills to Master

- Recognize that sequences are functions.
- Define and express a recursive sequence as a function.
- Recognize that a sequence has a domain which is a subset of integers.
- Generate a sequence given a recursive function.

Supports for Teachers

Critical Background Knowledge

- Use function notation.
- Identify and describe patterns.

Academic Vocabulary

Recursive, sequence, functions, domain, subset

Suggested Instructional Strategies

- Draw connections to writing arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.
- Have students generate recursive sequences from contexts and define them in recursive notation.

Resources

www.illuminations.NCTM.org

Counting the Trains

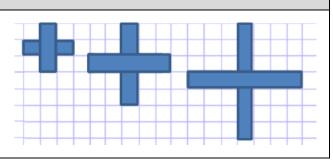
Sample Formative Assessment Tasks

Skill-based Task

Write a recursive formula in function notation for the sequence generated by adding 3 to each successive term when beginning with 7.

Problem Task

Draw the next arrangement of blocks in the sequence and describe the sequence using symbols.



Cluster Title: Interpret functions that arise in applications in terms of a context.

Standard F.IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.★

Concepts and Skills to Master

- Given a graph, identify key features such as x- and y-intercepts; intervals where the function is increasing, decreasing, positive, or negative.
- Given a table of values, identify key features such as x- and y-intercepts; intervals where the function is increasing, decreasing, positive, or negative.
- Find key features of a function and use them to graph the function.
- · Use interval notation and symbols of inequality to communicate key features of graphs.

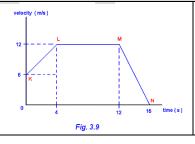
Supports for Teachers

Critical Background Knowledge Ability to graph a linear or exponential function from a table or equation. Academic Vocabulary Increasing, decreasing, positive, negative, intervals, intercepts, interval notation Suggested Instructional Strategies Use graphing technology to explore and identify key features of a function. Use key features of a function to graph functions by hand. Use key features of a function to graph functions by hand.

Sample Formative Assessment Tasks

Skill-based Task

Identify the intervals where the function is increasing and decreasing.



Problem Task

 Create a story that would generate a linear or exponential function and describe the meaning of key features of the graph as they relate to the story.

Cluster Title: Interpret functions that arise in applications in terms of a context.

Standard F.IF.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.★

Concepts and Skills to Master

- Identify domains of functions given a graph.
- Graph a function, given a restricted domain.
- Identify reasonability of a domain in a particular context.

Supports for Teachers

Critical Background Knowledge

- Familiarity with function notation and domain.
- Knowledge of independent and dependent variables

Academic Vocabulary

Domain, function, integers, independent variable, dependent variable

Suggested Instructional Strategies

- Discuss contexts where the domain of a function should be limited to a subset of integers, positive or negative values, or some other restriction to the real numbers.
- Find examples of functions with limited domains from other curricular areas (science, physical education, social studies, consumer science).

Resources

www.illuminations.NCTM.org

Domain Representations

Sample Formative Assessment Tasks

Skill-based Task

You are hoping to make a profit on the school play and have determined the function describing the profit to be f(t) = 8t - 2654 where t is the number of tickets sold. What is a reasonable domain for this function? Explain.

Problem Task

Create a function in context where the domain would be:

- All real numbers.
- Integers.
- Negative integers.
- Rational Numbers.
- (10, 40).

Cluster Title: Interpret functions that arise in applications in terms of a context.

Standard F.IF.6: Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.★

Concepts and Skills to Master

- Calculate rate of change given a linear function, from the equation or a table.
- Calculate rate of change over a given interval in an exponential function from an equation or a table where the domain is a subset of the integers.
- Use a graph to estimate the rate of change over an interval in a linear or exponential function.

Supports for Teachers

Critical Background Knowledge

• Definition of slope.

Academic Vocabulary

Increasing, decreasing, rate of change, average, function, interval

Suggested Instructional Strategies

• Use graphical data from birth rates, BMI in growing children, electricity rates, population growth or other linear or exponential data to explore and discuss the meaning of rate of change.

Resources

www.illuminations.NCTM.org:

- Drug Filtering
- Illuminations: Growth Rate

Sample Formative Assessment Tasks

Skill-based Task

Find the average rate of change on the interval [-3,1]

Table I								
Χ	-3	-2	-1	0	1	2	3	
Υ	8	3	-2	-7	-12	-17	-22	
Table 2								
Χ	-3	-2	-1	0	1	2	3	
Υ	6	12	24	48	96	192	384	
Table 3								
Χ	-3	-2	-1	0	1	2	3	
Υ	7	2	-1	0	2	4	6	

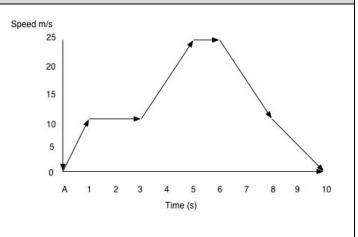
Task The graph models the speed of a car. Tell a story using the graph to describe what is

happening

in various

intervals.

Problem



Cluster Title: Analyze functions using different representations.

Standard F.IF.7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★

- a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
- b. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Concepts and Skills to Master

- Graph lines expressed in slope-intercept form or standard form by hand.
- Graph exponential functions by hand.
- Use technology to model complex exponential functions.
- · Identify intercepts in graphs of linear and exponential functions.

Supports for Teachers

Critical Background Knowledge						
Graph points on the coordinate plane.						
Academic Vocabulary						
Linear, exponential, intercept, end behavior						
Suggested Instructional Strategies		Resources				
Allow students to develop graphs from tables and use those graphs to generalize graphing strategies.		Kuta Software Worksheets (free online)Geogebra (free online)				
Graph equations generated from real-life contexts. Sample Formative Assessment Tasks						
Skill-based Task	Problem Task					
• Graph the function $f(x) = 2x - 3$.	The population of salmon in a lake triples each year. The					
• Graph the function $y = 2^x$.	current population is 472. Model the situation graphically. Include the last three years and the next two. Model the situation with a function.					

★Modeling

Cluster Title: Analyze functions using different representations.

Standard F.IF.9: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Concepts and Skills to Master

- Compare slopes and intercepts of two linear functions where one is represented algebraically, graphically, numerically, in tables, or in a description and the other is modeled using a different form of representation.
- Compare growth rate and intercepts of two exponential functions where one is represented algebraically, graphically, numerically, in tables, or in a description and the other is modeled using a different form of representation.

Supports for Teachers

Critical Background Knowledge

- Find slope and intercepts of linear functions.
- Find intercepts and growth rates of exponential functions.

Academic Vocabulary

Function, slope, rate of change, intercept, interval, growth rate.

Suggested Instructional Strategies

- Compare two functions expressed in different representations.
 Ask: Which is growing at a faster rate? Which one begins at a higher value? Why does it increase faster than the other?
 How do you know?
- Match functions expressed using different representations that have the same properties.

Resources

- Exponential functions on the Web: <u>http://faculty.gvsu.edu/goldenj/exponential.</u>
- Geogebra (free online)
- Graphing calculators

Skill-based Task

Which has a greater slope?

- $\bullet \quad f(x) = 3x + 5$
- A function representing the number of bottle caps in a shoebox where 5 are added each time

Problem Task

Create a graphic organizer to highlight your understanding of functions and their properties by comparing two functions using at least two different representations.